

SYSTEM FOR DETECTING, DIAGNOSING, AND TREATING CARDIOVASCULAR DISEASE
Mann, et al.
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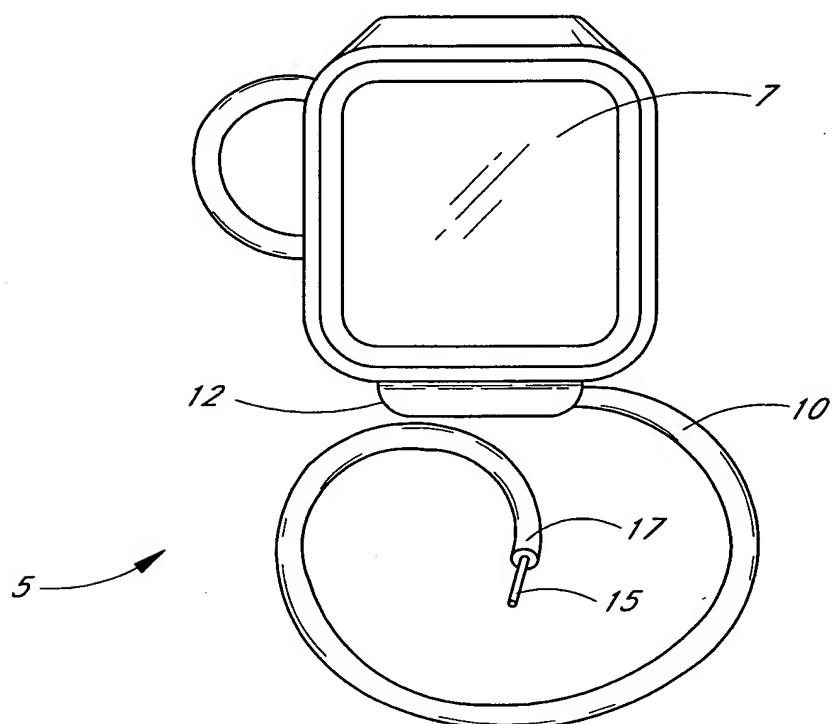


FIG. 1

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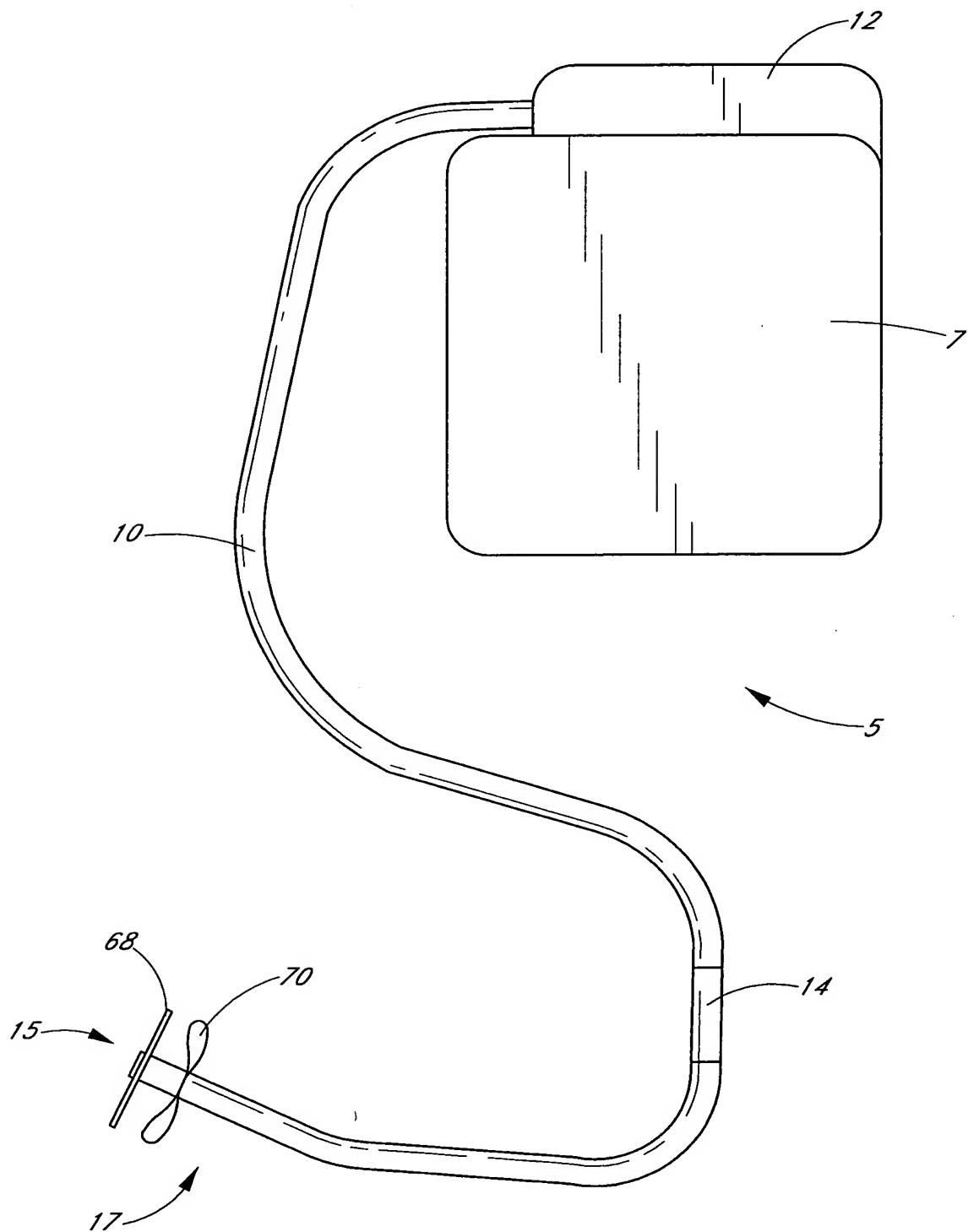


FIG. 2

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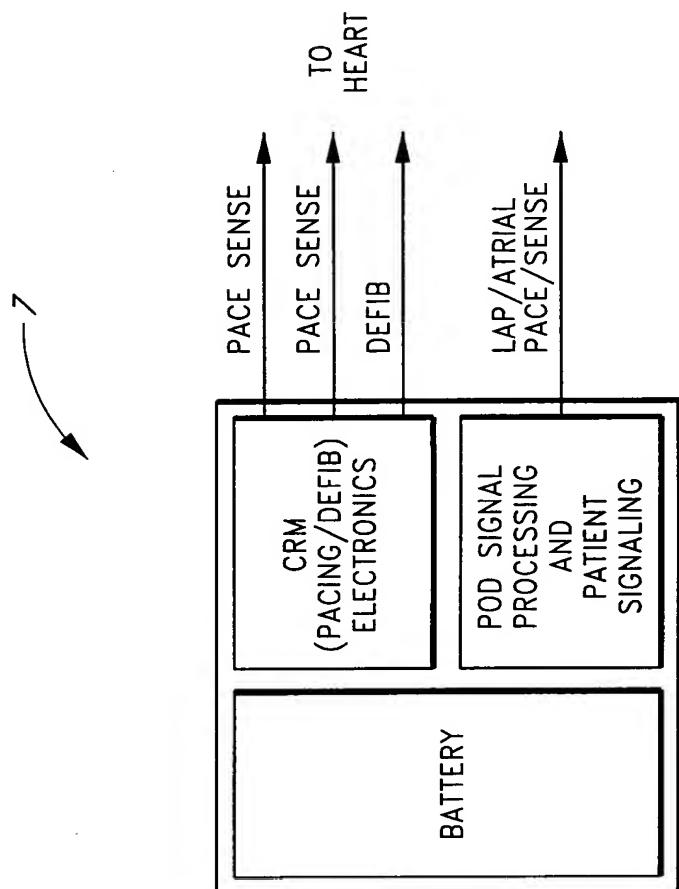


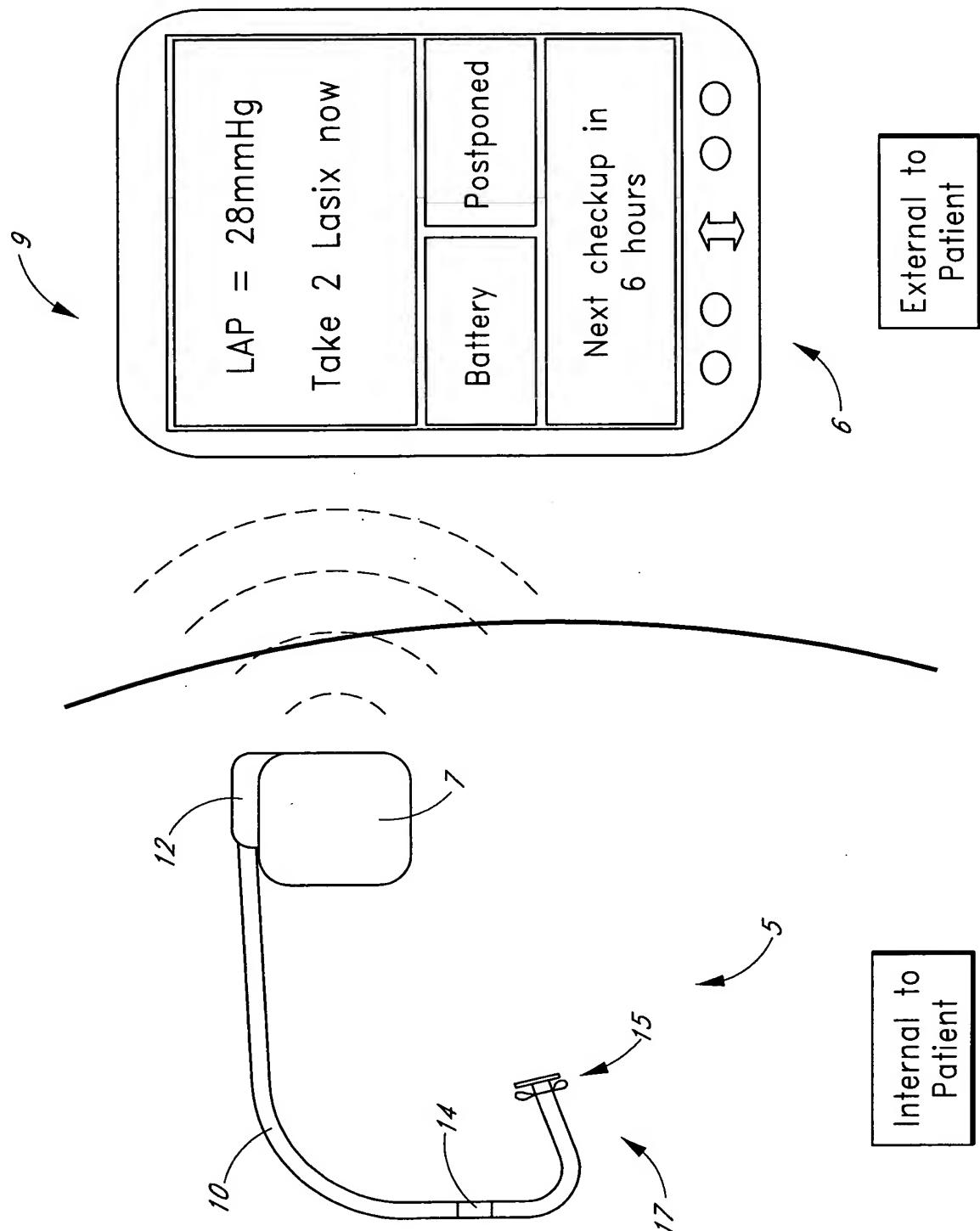
FIG. 3

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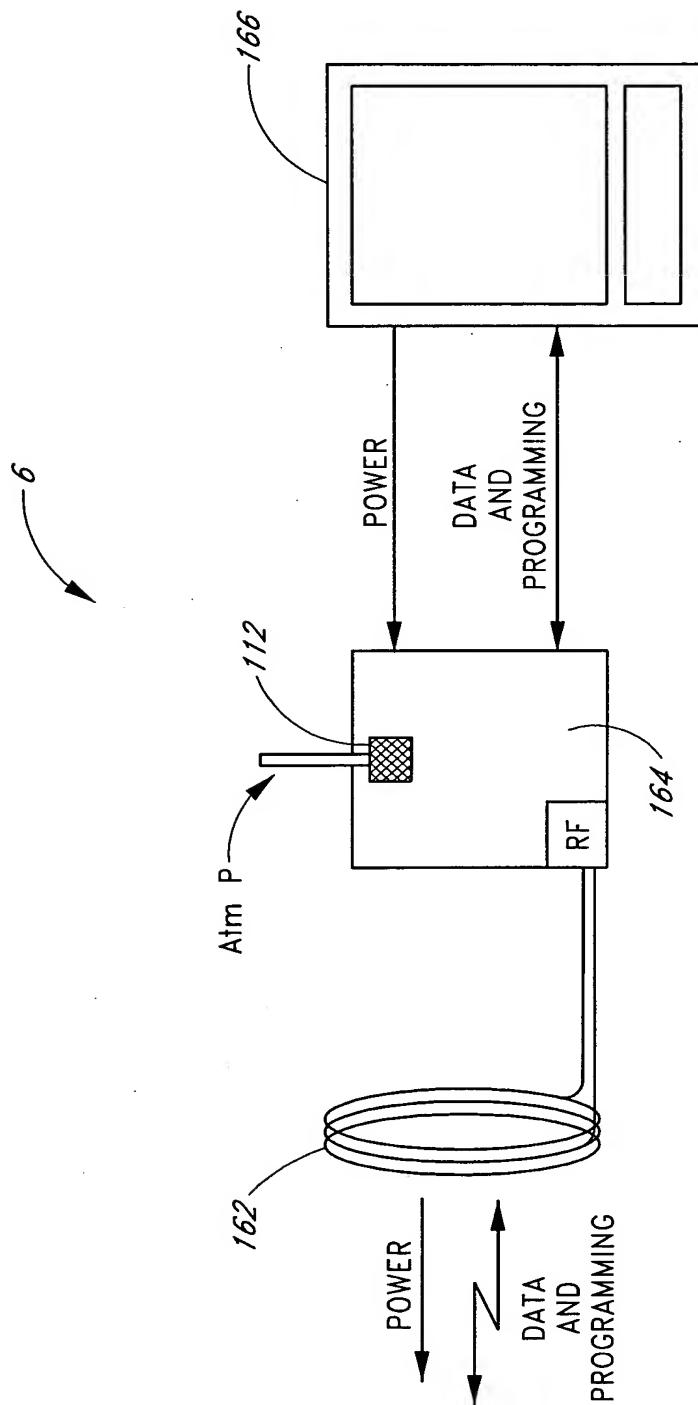


FIG. 5

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Right Atrial Pressure Waveforms

FIG. 6A

Low mean atrial pressure

1. Hypovolemia
2. Improper zeroing of the transducer

Elevated mean atrial pressure

1. Intravascular volume overload states
2. Right ventricular failure due to valvular disease (tricuspid or pulmonic stenosis or regurgitation)
3. Right ventricular failure due to myocardial disease (right ventricular ischemia, cardiomyopathy)
4. Right ventricular failure due to left heart failure (mitral stenosis/regurgitation, aortic stenosis/regurgitation, cardiomyopathy, ischemia)
5. Right ventricular failure due to increased pulmonary vascular resistance (pulmonary embolism, chronic obstructive pulmonary disease, primary pulmonary hypertension)
6. Pericardial effusion with tamponade physiology
7. Obstructive atrial myxoma

Elevated a wave (any increase to ventricular filling)

1. Tricuspid stenosis
2. Decreased ventricular compliance due to ventricular failure, pulmonic valve stenosis, or pulmonary hypertension

Cannon a wave

1. Atrial-ventricular asynchrony (atria contract against a closed tricuspid valve, as during complete heart block following premature ventricular contraction, during ventricular tachycardia, with ventricular pacemaker)

Absent a wave

1. Atrial fibrillation or atrial standstill
2. Atrial flutter

Elevated v wave

1. Tricuspid regurgitation
2. Right ventricular heart failure
3. Reduced atrial compliance (restrictive myopathy)

a wave equal to v wave

1. Tamponade
2. Constrictive pericardial disease
3. Hypervolemia

Prominent x descent

1. Tamponade
2. Subacute constriction and possibly chronic constriction
3. Right ventricular ischemia with preservation of atrial contractility

Prominent y descent

1. Constrictive pericarditis
2. Restrictive myopathies
3. Tricuspid regurgitation

Blunted x descent

1. Atrial fibrillation
2. Right atrial ischemia

Blunted y descent

1. Tamponade
2. Right ventricular ischemia
3. Tricuspid stenosis

Miscellaneous abnormalities

1. Kussmaul's sign (inspiratory rise or lack of decline in right atrial pressure)-constrictive pericarditis, right ventricular ischemia
2. Equalization (<5 mm Hg) of mean right atrial, right ventricular diastolic, pulmonary artery diastolic, pulmonary capillary wedge, and pericardial pressures in tamponade
3. M or W patterns: right ventricular ischemia, pericardial constriction, congestive heart failure
4. Ventricularization of the right atrial pressure: severe tricuspid regurgitation
5. Saw tooth pattern: atrial flutter
6. Dissociation between pressure recording and intracardiac ECG: Ebstein's anomaly

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Left Atrial Pressure/Pulmonary Capillary Wedge Pressure Waveforms

Low mean atrial pressure

1. Hypovolemia
2. Improper zeroing of the transducer

Elevated mean atrial pressure

1. Intravascular volume overload states
2. Left ventricular failure due to valvular disease (mitral or aortic stenosis or regurgitation)
3. Left ventricular failure due to myocardial disease (ischemia or cardiomyopathy)
4. Left ventricular failure due to systemic hypertension
5. Pericardial effusion with tamponade physiology
6. Obstructive atrial myxoma

Elevated a wave (any increase to ventricular filling)

1. Mitral stenosis
2. Decreased ventricular compliance due to ventricular failure, aortic valve stenosis, or systemic hypertension

Cannon a wave

1. Atrial-ventricular asynchrony (atria contract against a closed mitral valve, as during complete heart block following premature ventricular contraction, during ventricular tachycardia, with ventricular pacemaker)

Absent a wave

1. Atrial fibrillation or atrial standstill
2. Atrial flutter

Elevated v wave

1. Mitral regurgitation
2. Left ventricular heart failure
3. Ventricular septal defect

a wave equal to v wave

1. Tamponade
2. Constrictive pericardial disease
3. Hypervolemia

Prominent x descent

1. Tamponade
2. Subacute constriction and possibly chronic constriction
3. Right ventricular ischemia with preservation of atrial contractility

Prominent y descent

1. Constrictive pericarditis
2. Restrictive myopathies
3. Mitral regurgitation

Blunted x descent

1. Atrial fibrillation
2. Atrial ischemia

Blunted y descent

1. Tamponade
2. Ventricular ischemia
3. Mitral stenosis

Pulmonary capillary wedge pressure not equal to left ventricular end-diastolic pressure

1. Mitral stenosis
2. Left atrial myxoma
3. Cor triatriatum
4. Pulmonary venous obstruction
5. Decreased ventricular compliance
6. Increased pleural pressure
7. Placement of catheter in a nondependent zone of lung

FIG. 6B

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Pulmonary Artery Pressure Waveforms

Elevated systolic pressure

1. Primary pulmonary hypertension
2. Mitral stenosis or regurgitation
3. Congestive heart failure
4. Restrictive myopathies
5. Significant left to right shunt
6. Pulmonary disease (pulmonary embolism, chronic obstructive pulmonary disease)

Reduced systolic pressure

1. Hypovolemia
2. Pulmonary artery stenosis
3. Sub- or supravalvular stenosis
4. Ebstein's anomaly
5. Tricuspid stenosis
6. Tricuspid atresia

Reduced pulse pressure

1. Right heart ischemia
2. Right ventricular infarction
3. Pulmonary embolism
4. Tamponade

Bifid pulmonary artery waveform

1. Large left atrial v wave transmitted backward (i.e., MR)

Pulmonary artery diastolic pressure greater than pulmonary capillary wedge pressure

1. Pulmonary disease
2. Pulmonary embolus
3. Tachycardia

FIG. 6C

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FIG. 7

PARAMETERS MEASURED	Mean	Respiratory Component	Cardiac Component	Intracardiac ECG		Co-re Temp
				RA	LA	
DIAGNOSIS						
Cardiac hemodynamics						
CHF - compensated	↔	↔	↔			
CHF - mild	↑↑	↑↑	↑↑	↑↑	↑↑	
CHF - moderate	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑	
CHF - severe	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	
CHF - overtreated	↓	↓	↓	↑↑	↑↑	
CHF - mitral regurgitations	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	
CHF - rapid onset	↓↓	↓↓	↓↓	↓↓	↓↓	
CHF - acute mitral regurgitations	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	
Cardiac tamponade	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	
Myocardial ischemia	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑	
Cardiac rhythm						
Normal Sinus Rhythm						50-100 SR
Sinus Tachycardia						>100 SR
Sinus Bradyarrhythmia						<30 SR
Supraventricular Tachycardia						>120 Reg QRS
Atrial Fibrillation - controlled						60-100 Irreg. no p-wave
Atrial Fibrillation - rapid						>100 Irreg. no p-wave
Ventricular Tachycardia						Cannon s-waves >20 Reg QRS >110 msec: AV dissociation
Complete Heart Block						Cannon s-waves <50 AV dissociation
New cardiac						
Respiratory Distress	↔↑	↔↑	↔↑	↑↑	↑↑	
Hyperthermia						
Hypothermia						

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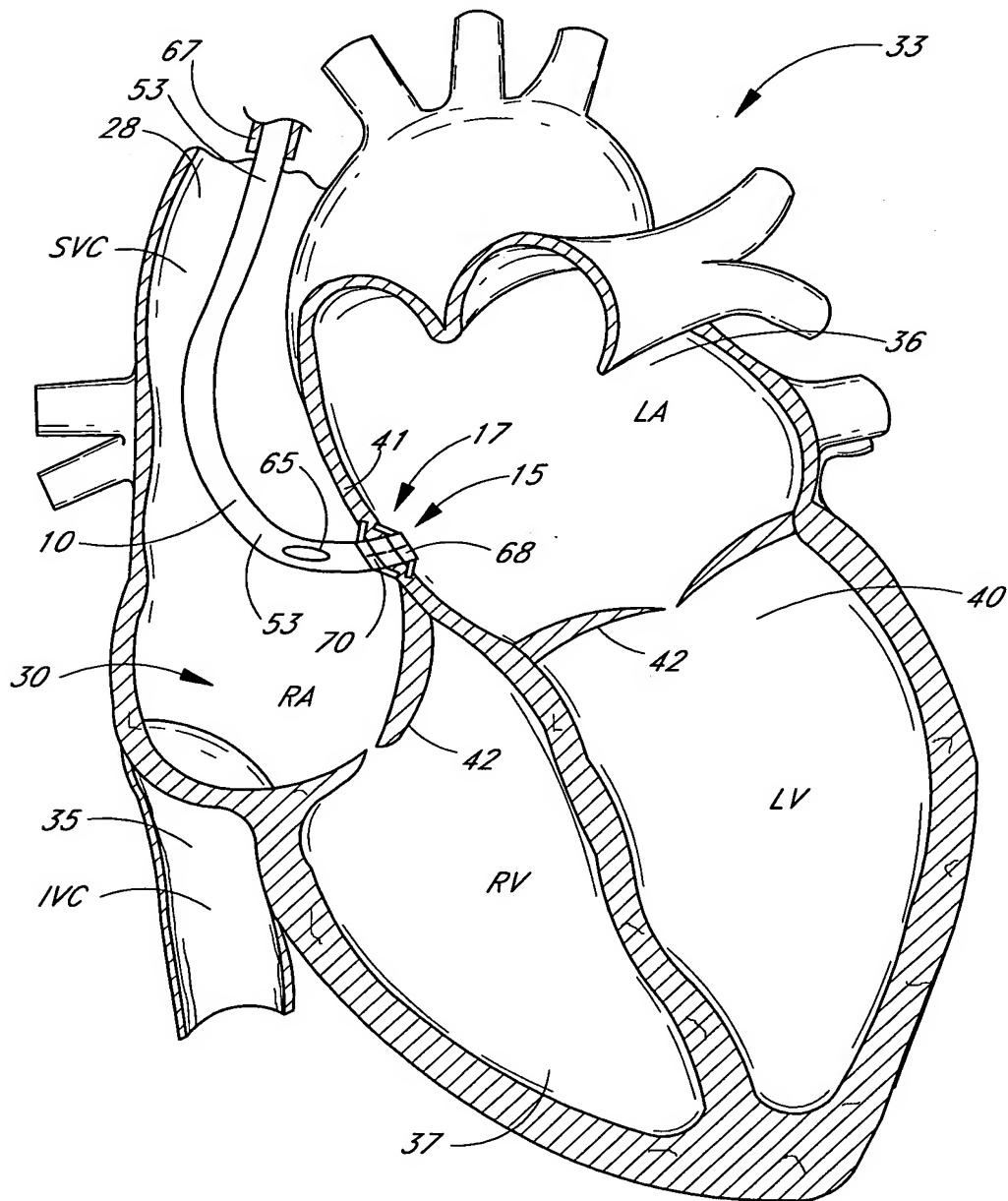


FIG. 8

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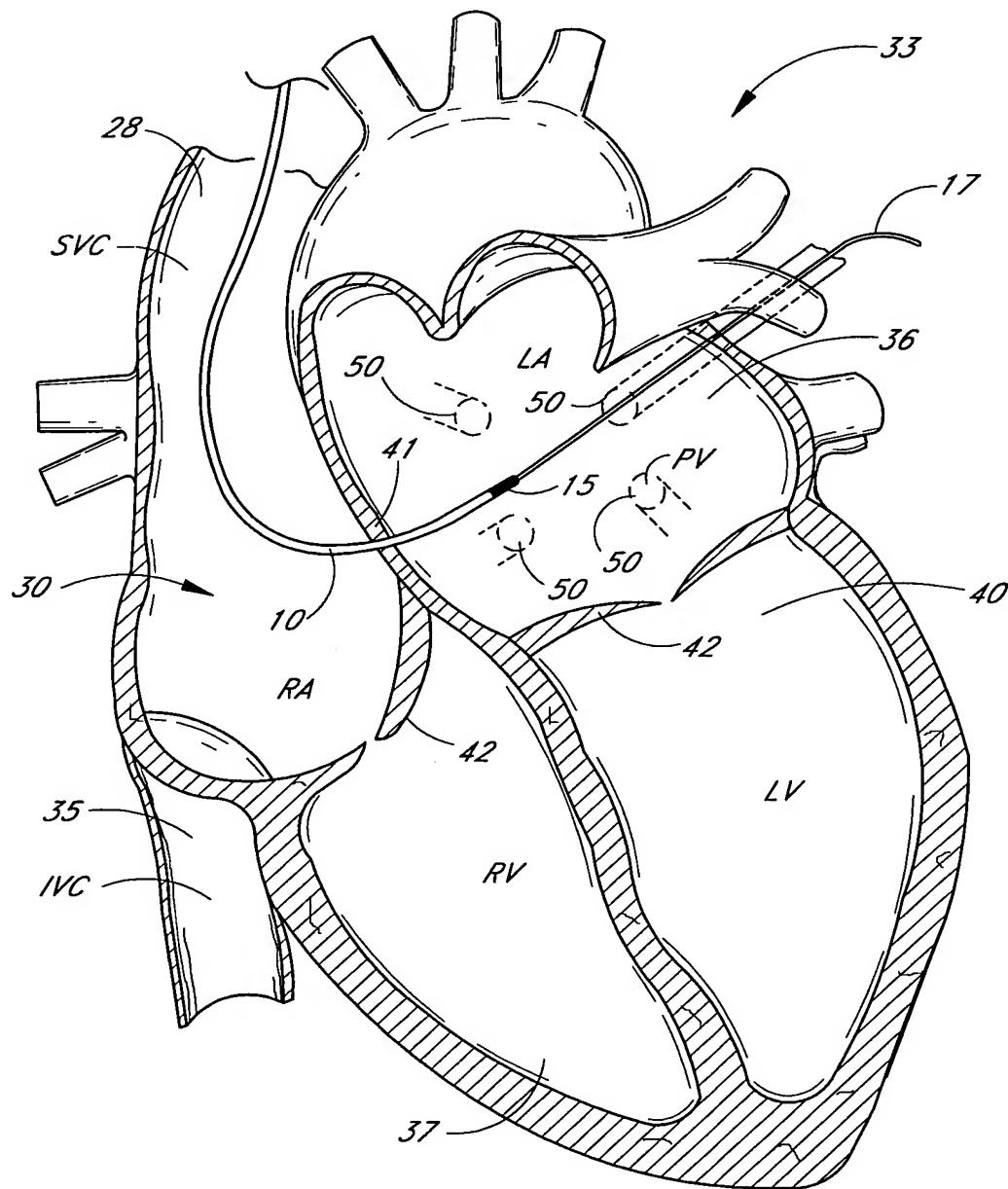


FIG. 9

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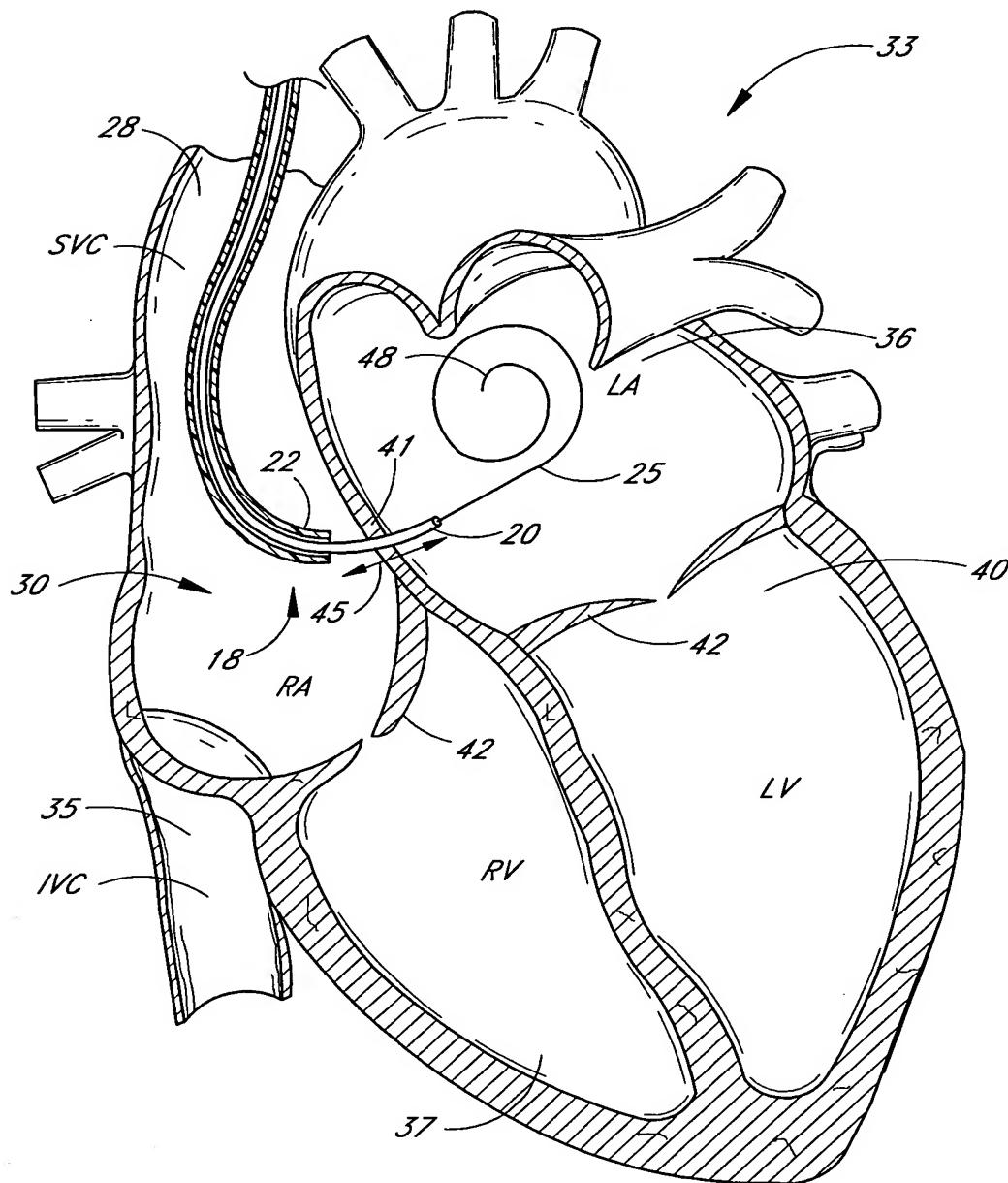


FIG. 10

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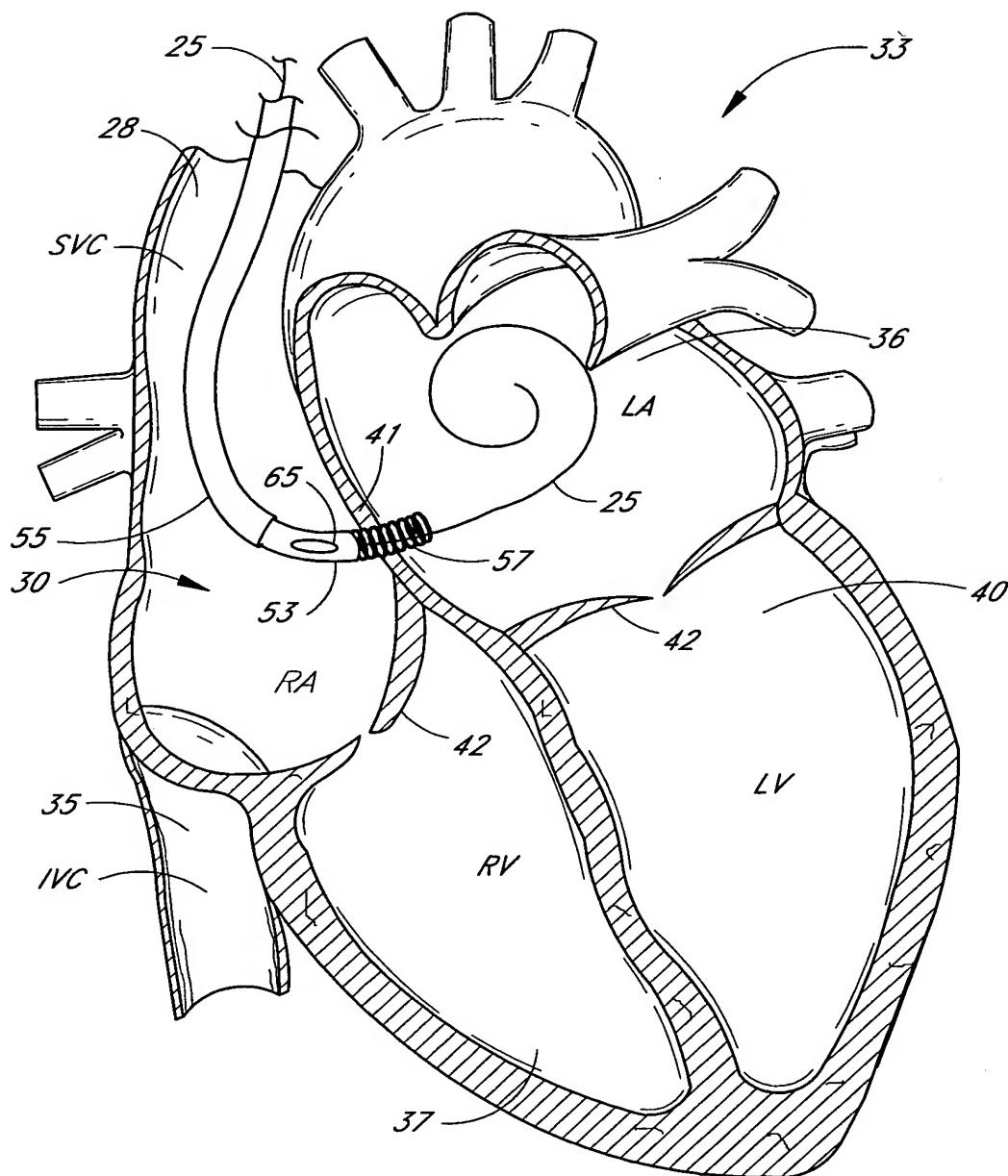


FIG. 11

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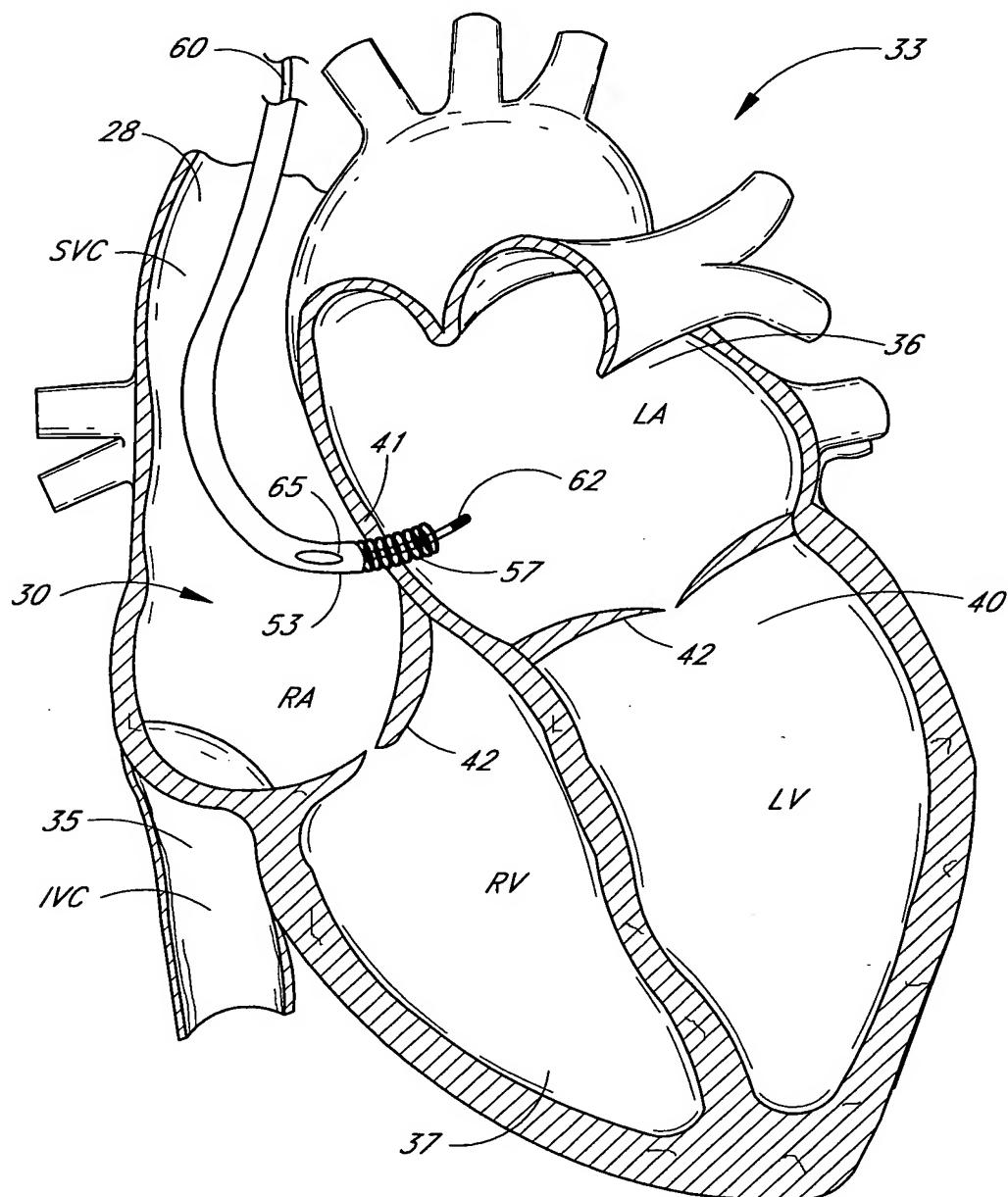


FIG. 12

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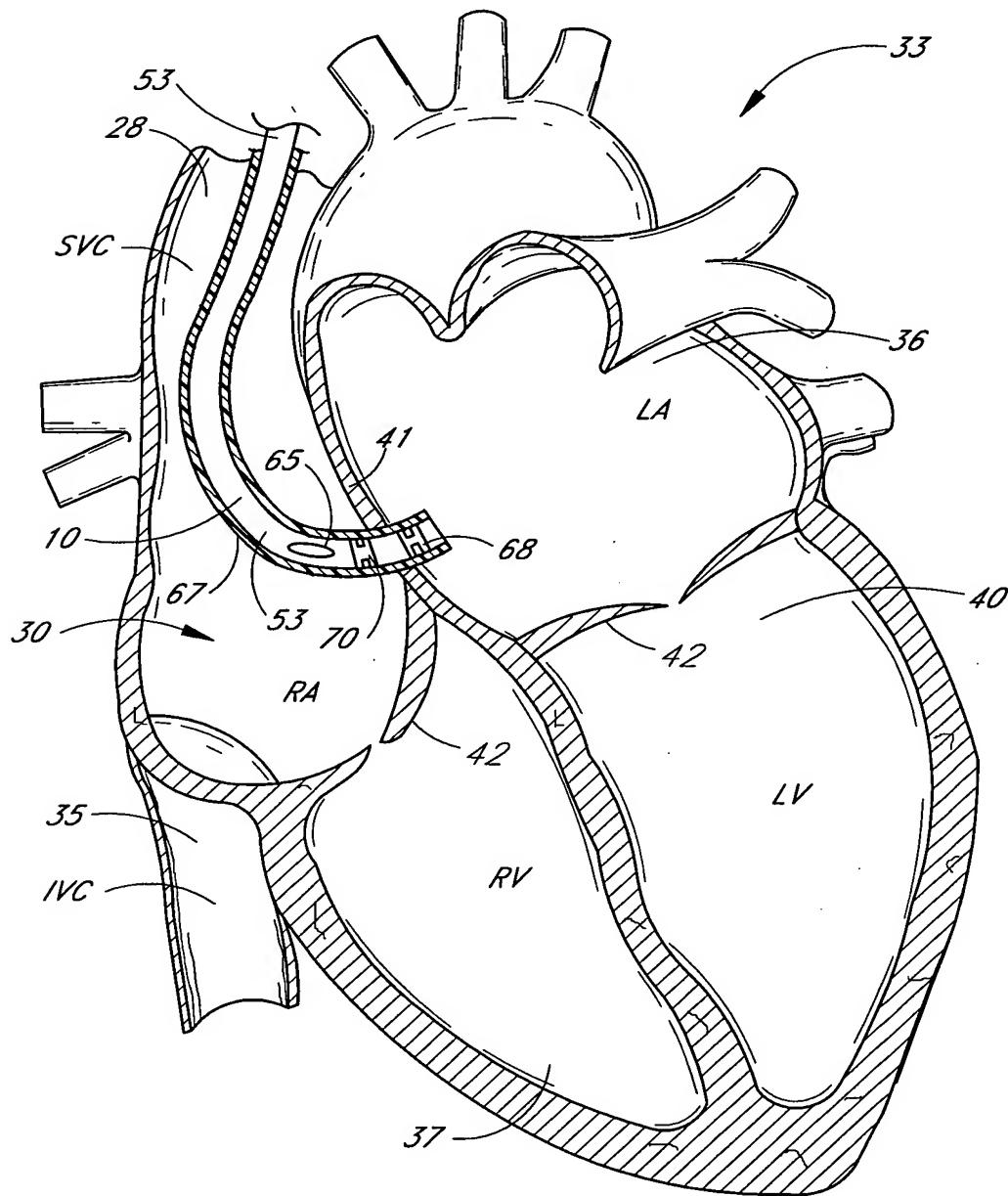


FIG. 13

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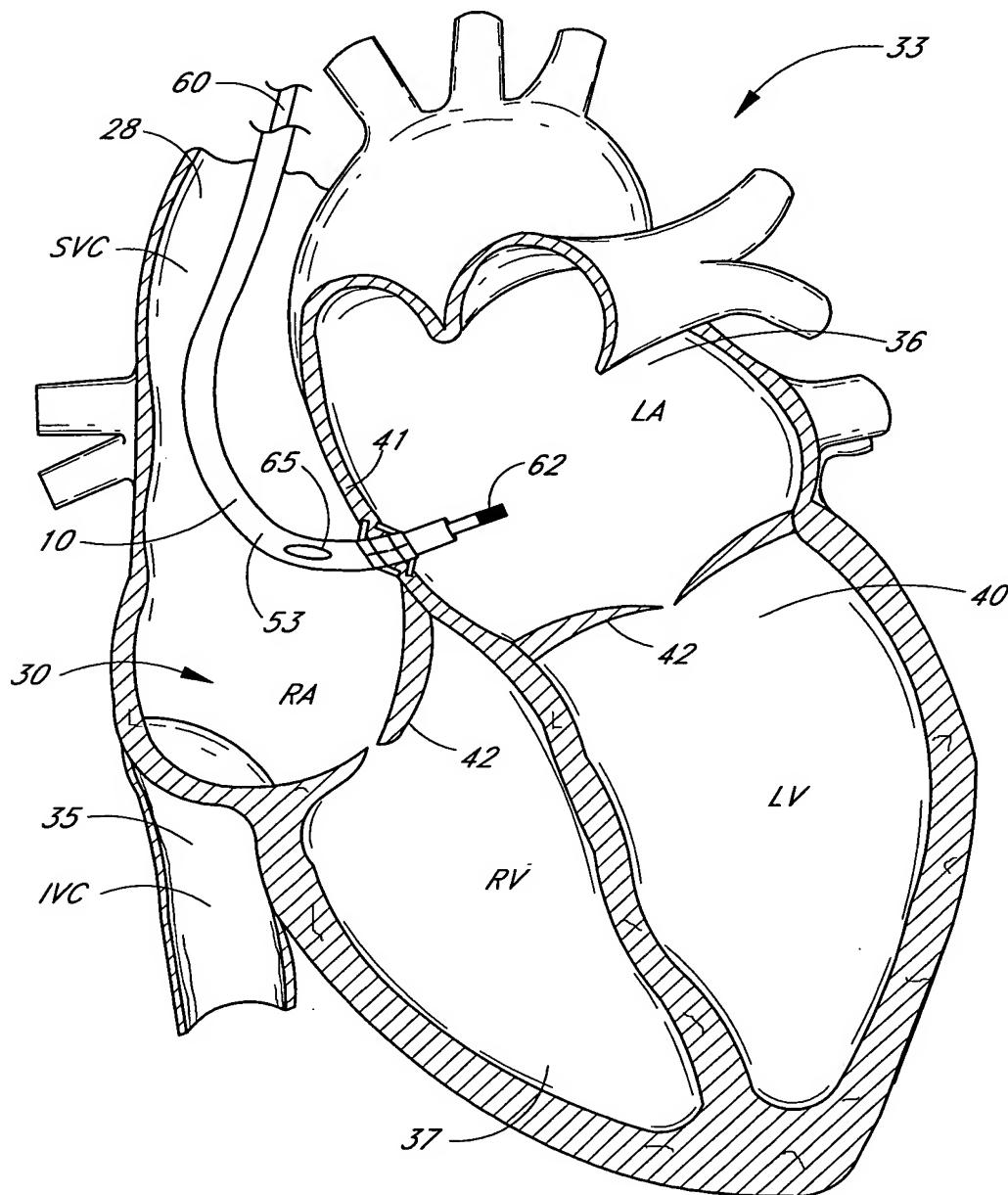


FIG. 14

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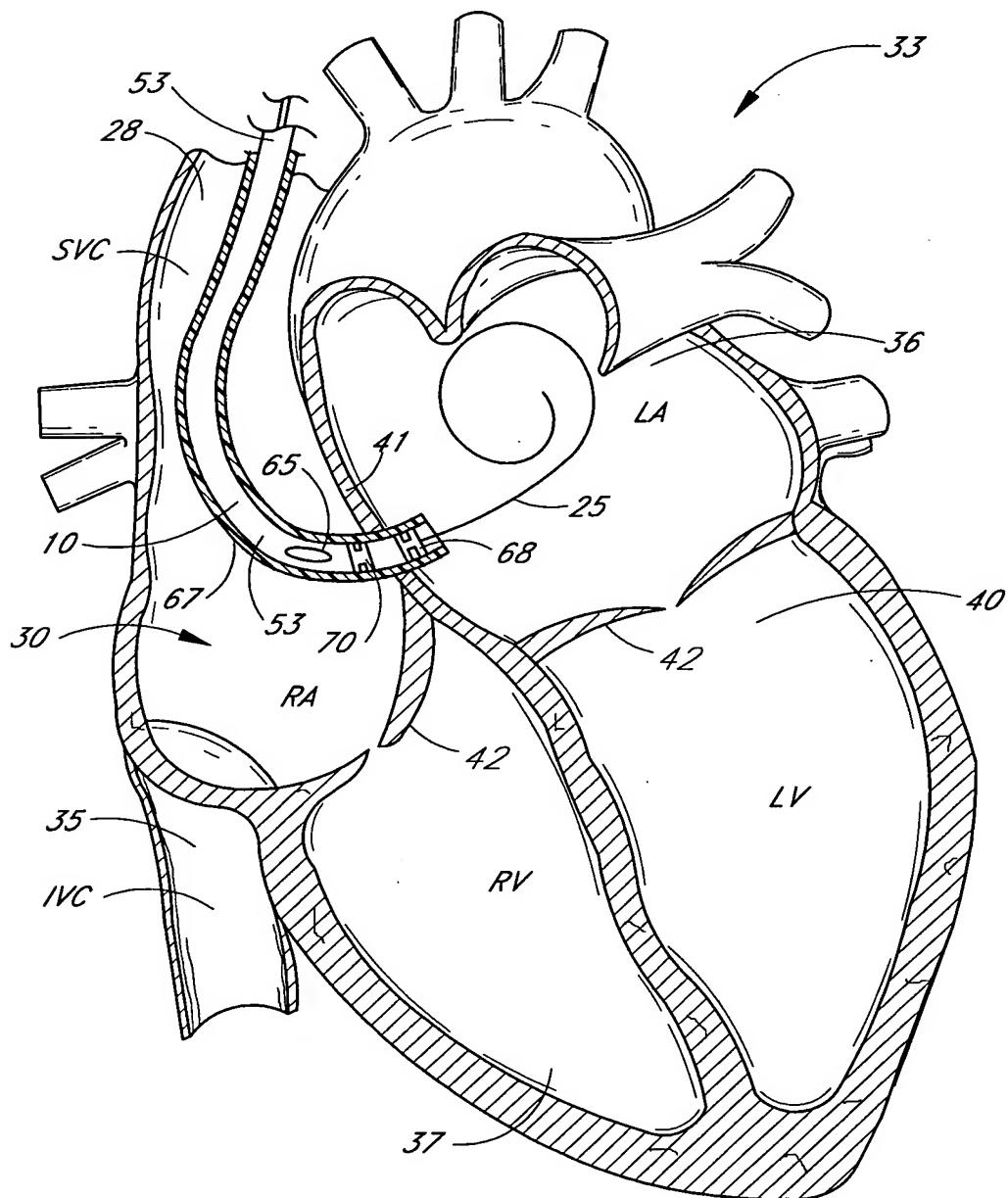


FIG. 15

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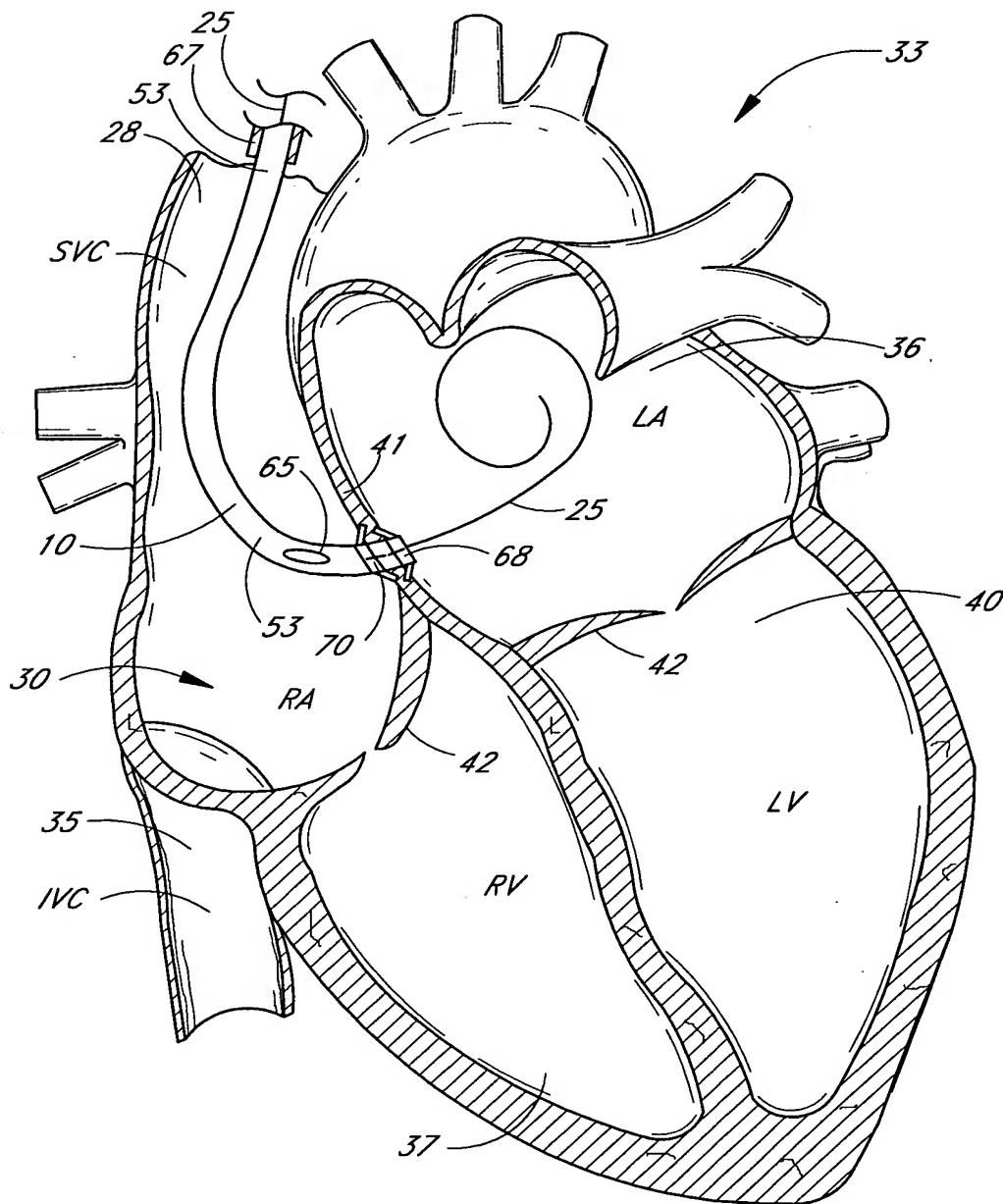


FIG. 16

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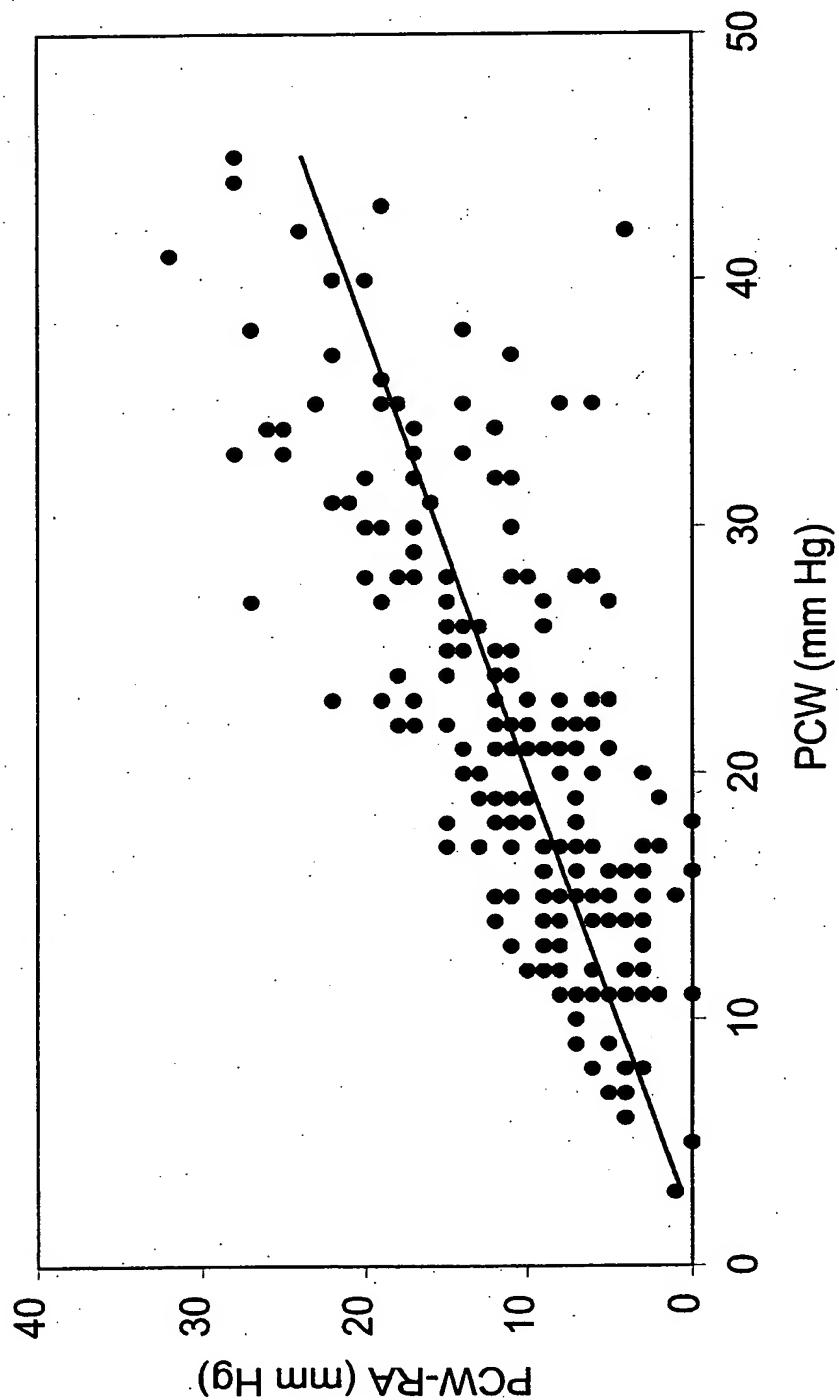


FIG. 17

Typical normal pressure tracings:

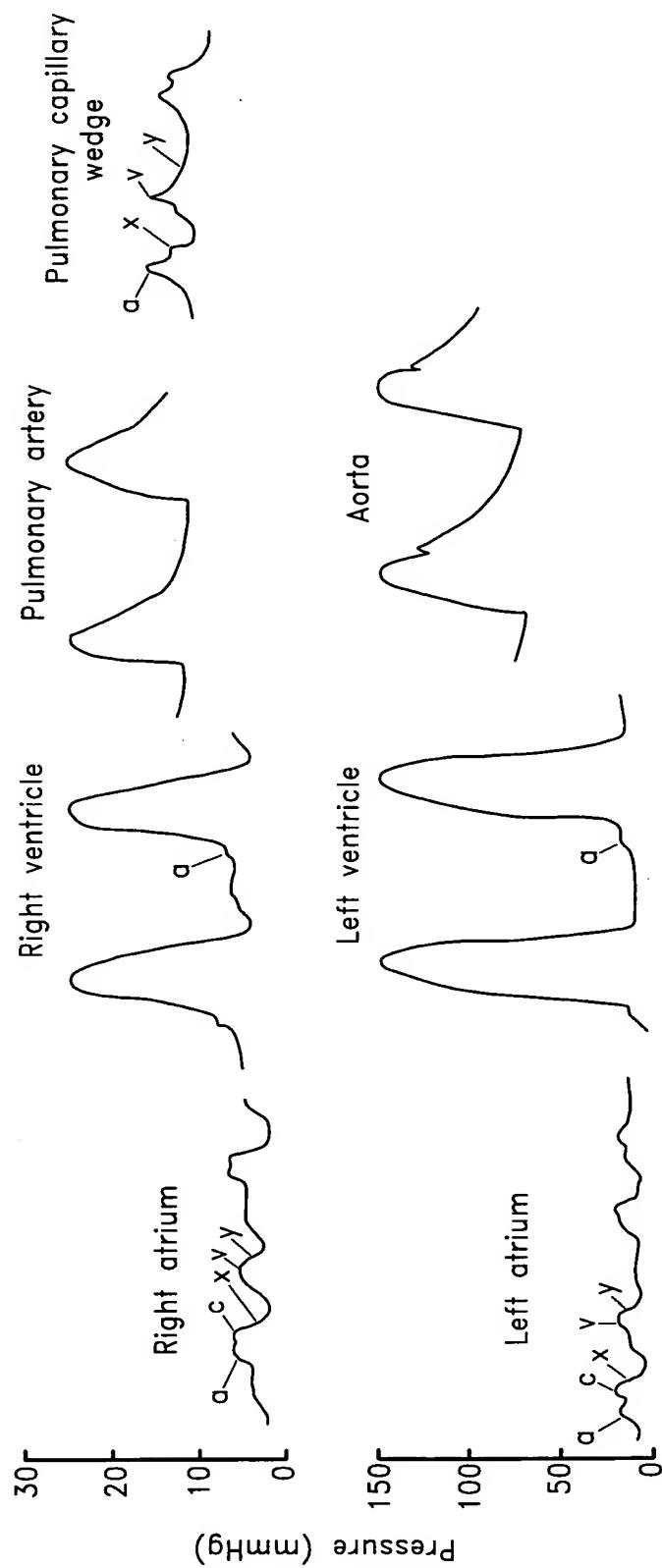


FIG. 18

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PRESSESSES	Average (mm HG)	Range (mm HG)
Right atrium		
a wave	6	2-7
v wave	5	2-7
mean	3	1-5
Right ventricle		
peak systolic	25	15-30
end-diastolic	4	4-7
Pulmonary artery		
peak systolic	25	15-30
end-diastolic	9	4-12
mean	15	9-10
Pulmonary capillary wedge		
mean	9	4-12
Left atrium		
a wave	10	4-16
v wave	12	6-21
mean	8	2-12
Left ventricle		
peak systolic	130	90-140
end-diastolic	8	5-12
Central aorta		
peak systolic	130	90-140
end-diastolic	70	60-80
mean	85	70-105
VASCULAR RESISTANCES	MEAN (dyne-sec-cm ⁻⁵)	RANGE (dyne-sec-cm)
Systemic vascular resistance	1100	700-1600
Total pulmonary resistance	200	100-3000
Pulmonary vascular resistance	70	20-1300

FIG. 19

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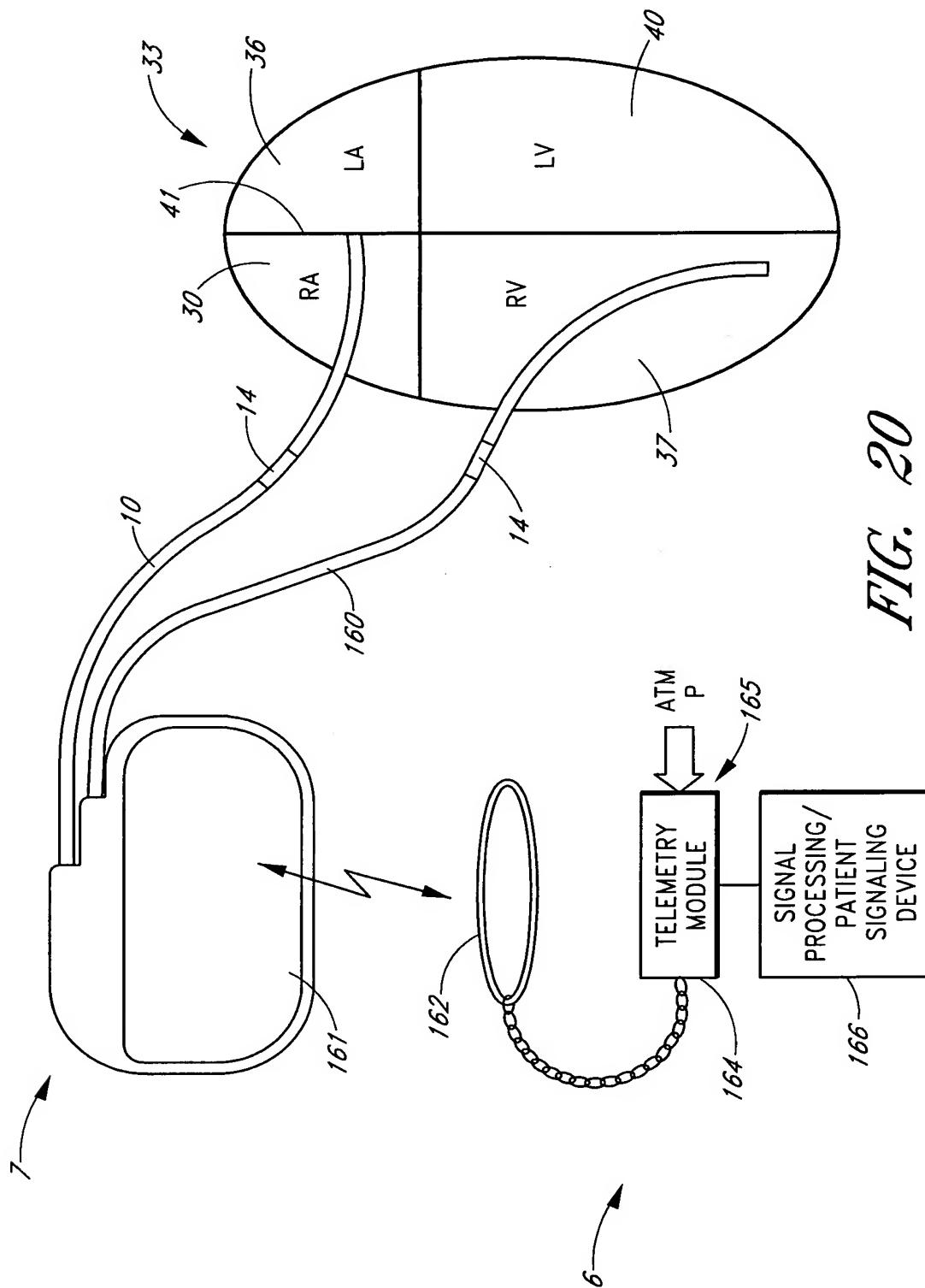


FIG. 20

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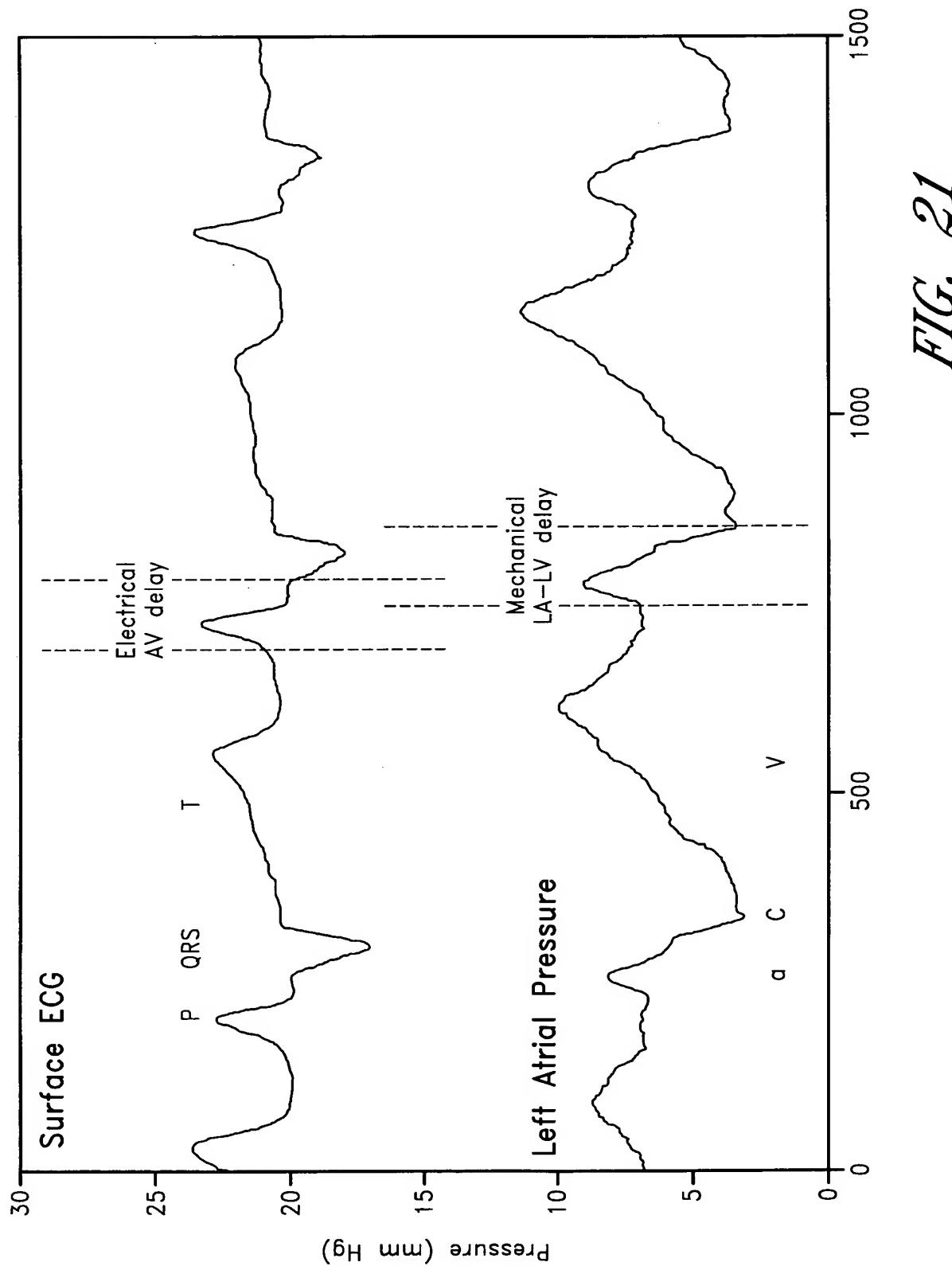


FIG. 21

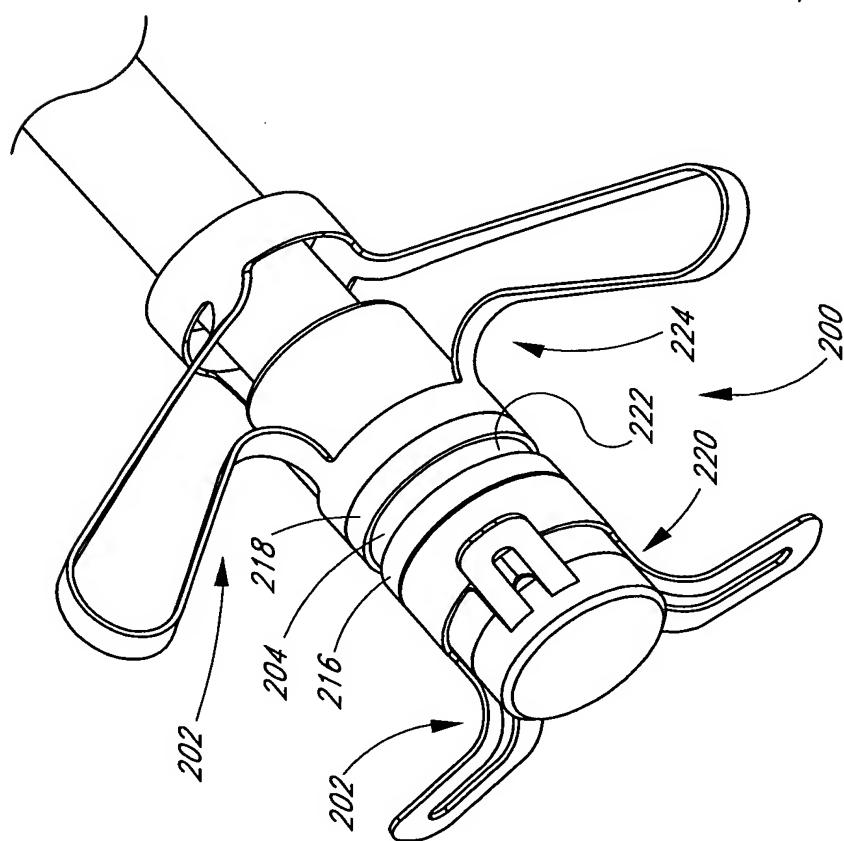
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FIG. 22



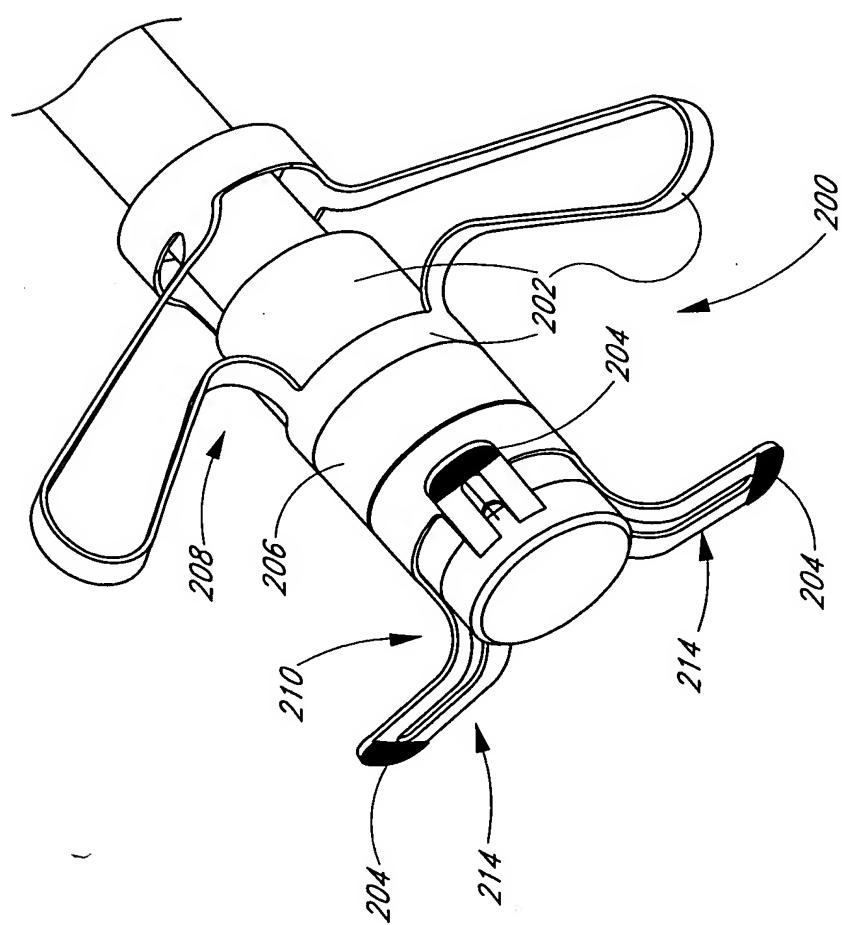
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FIG. 23



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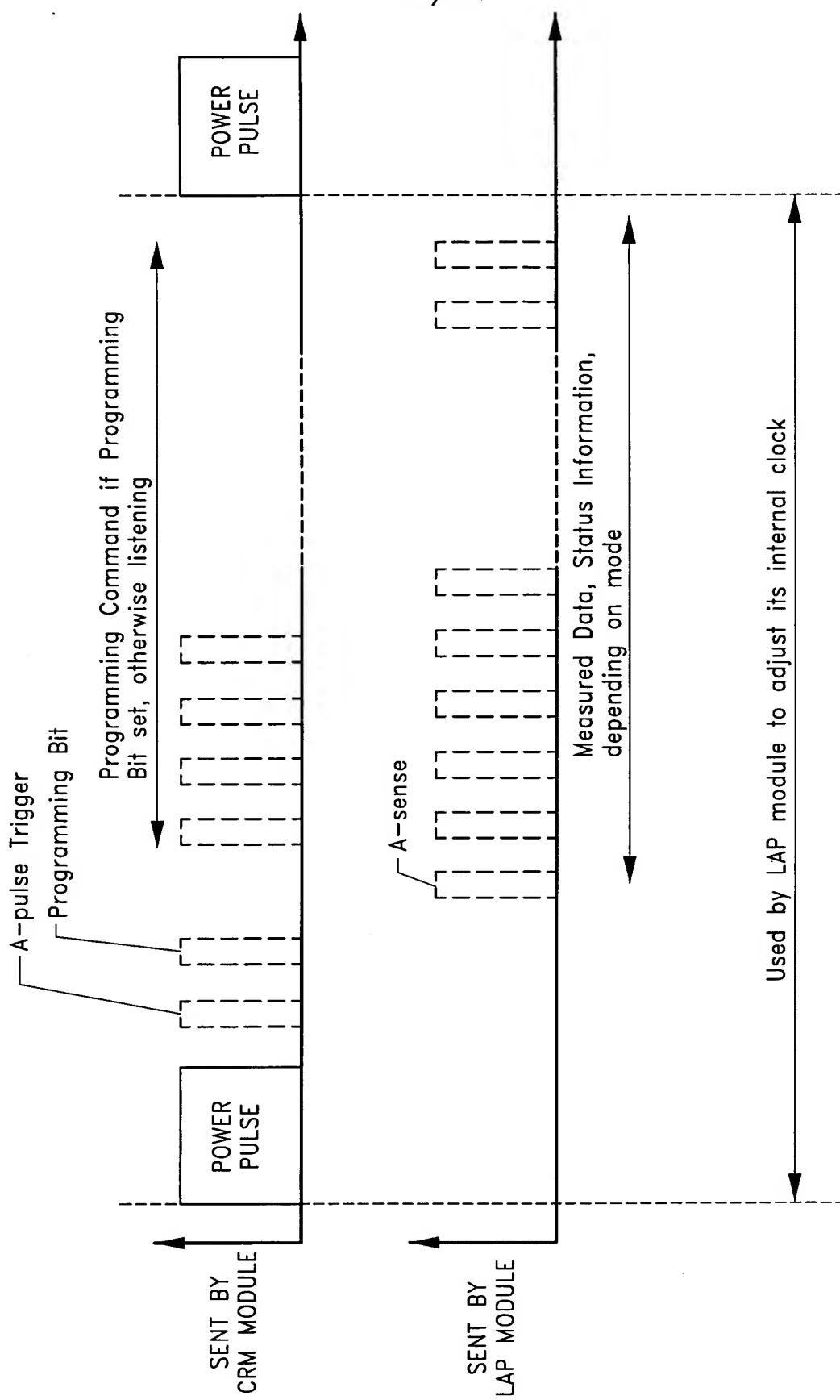


FIG. 24

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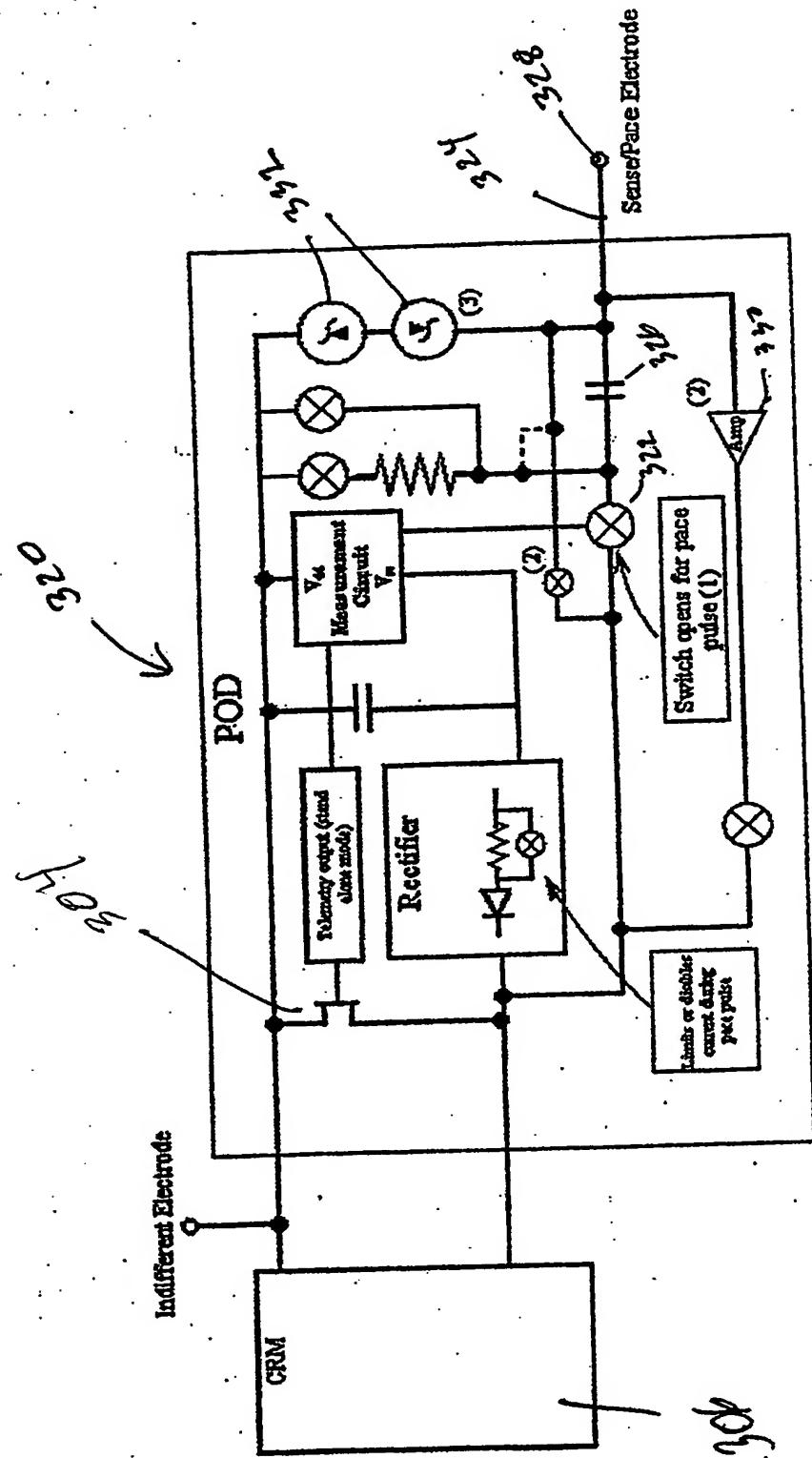


FIG. 25

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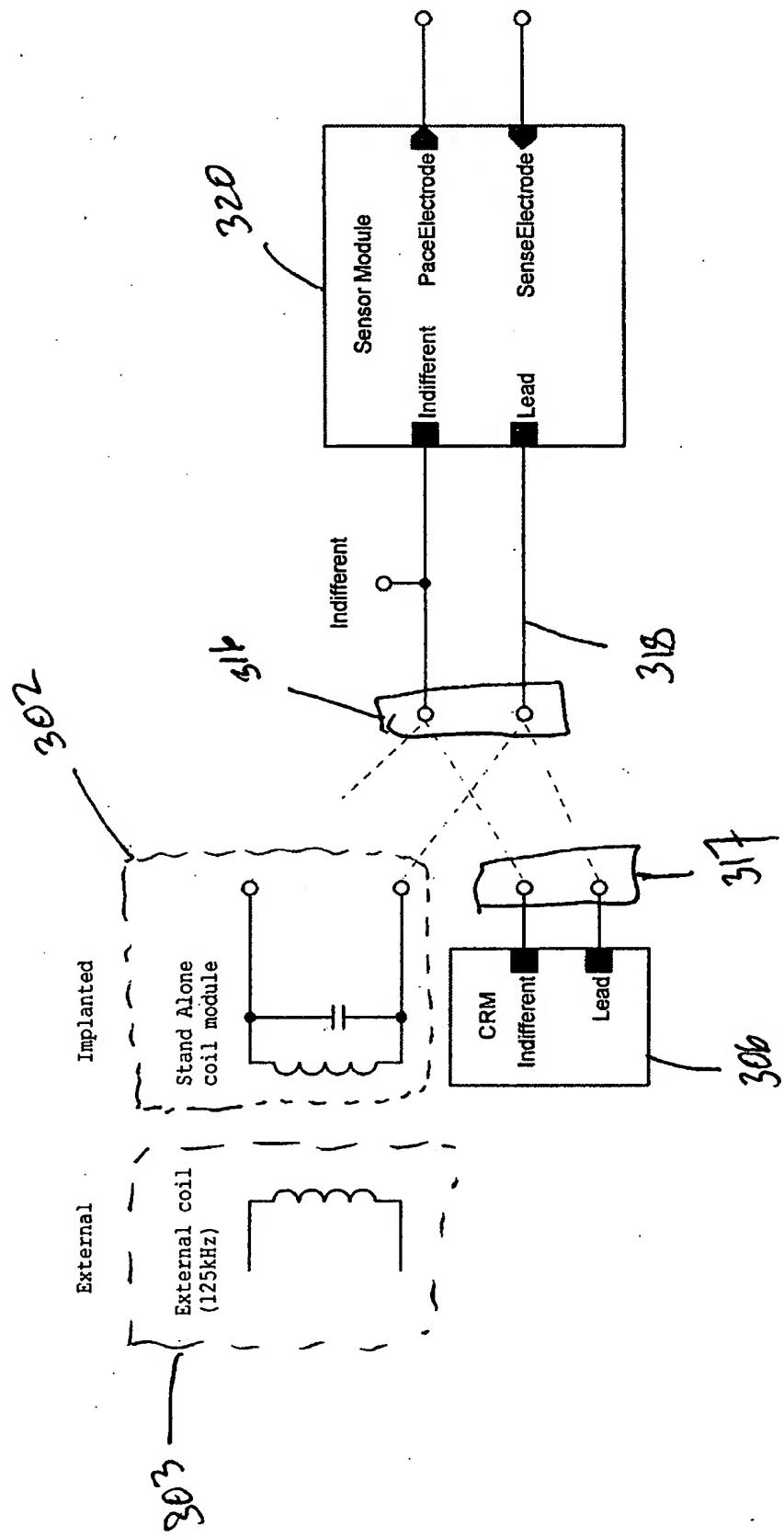


FIG. 26A

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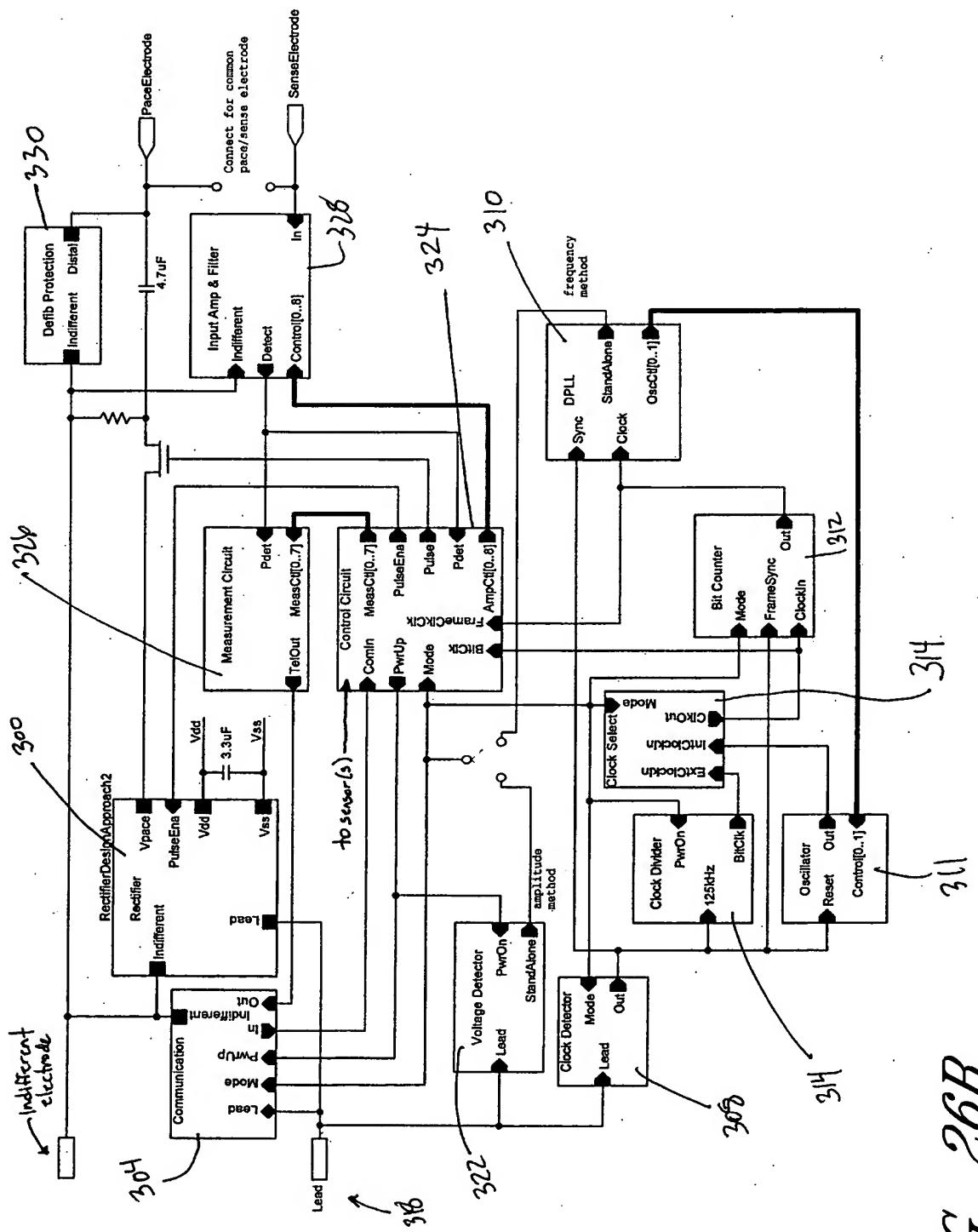


FIG. 26B

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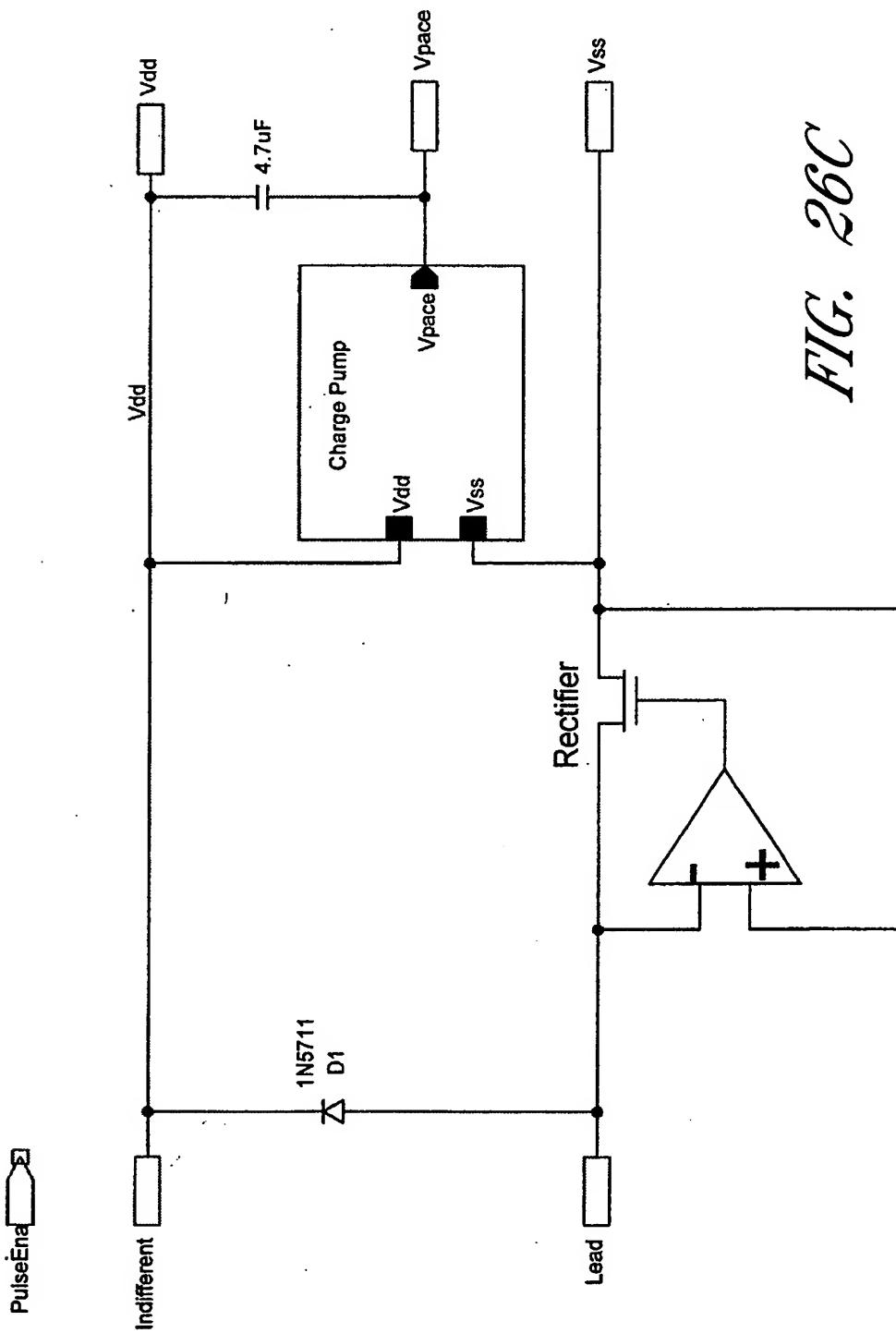


FIG. 26C

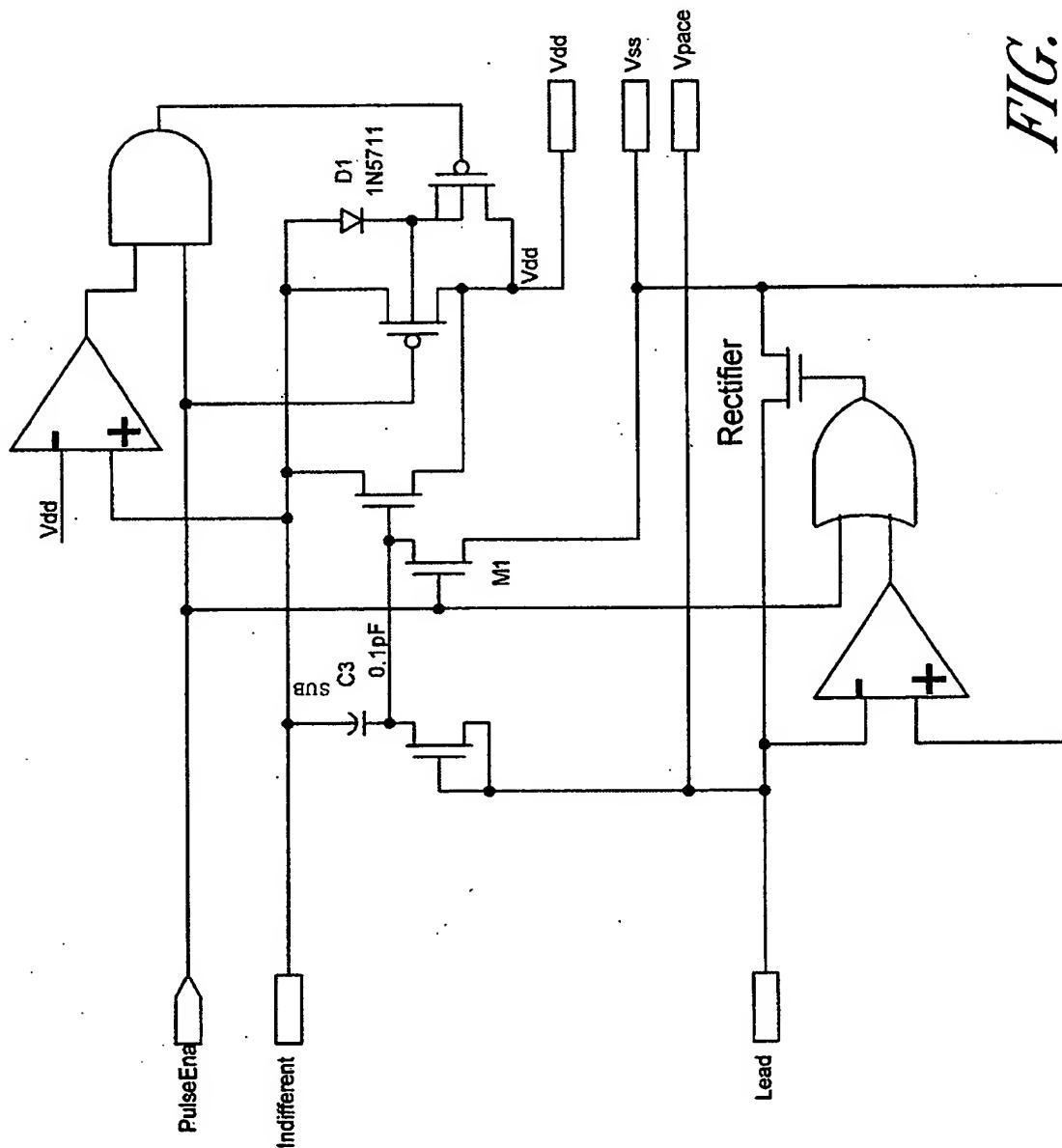
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FIG. 26D



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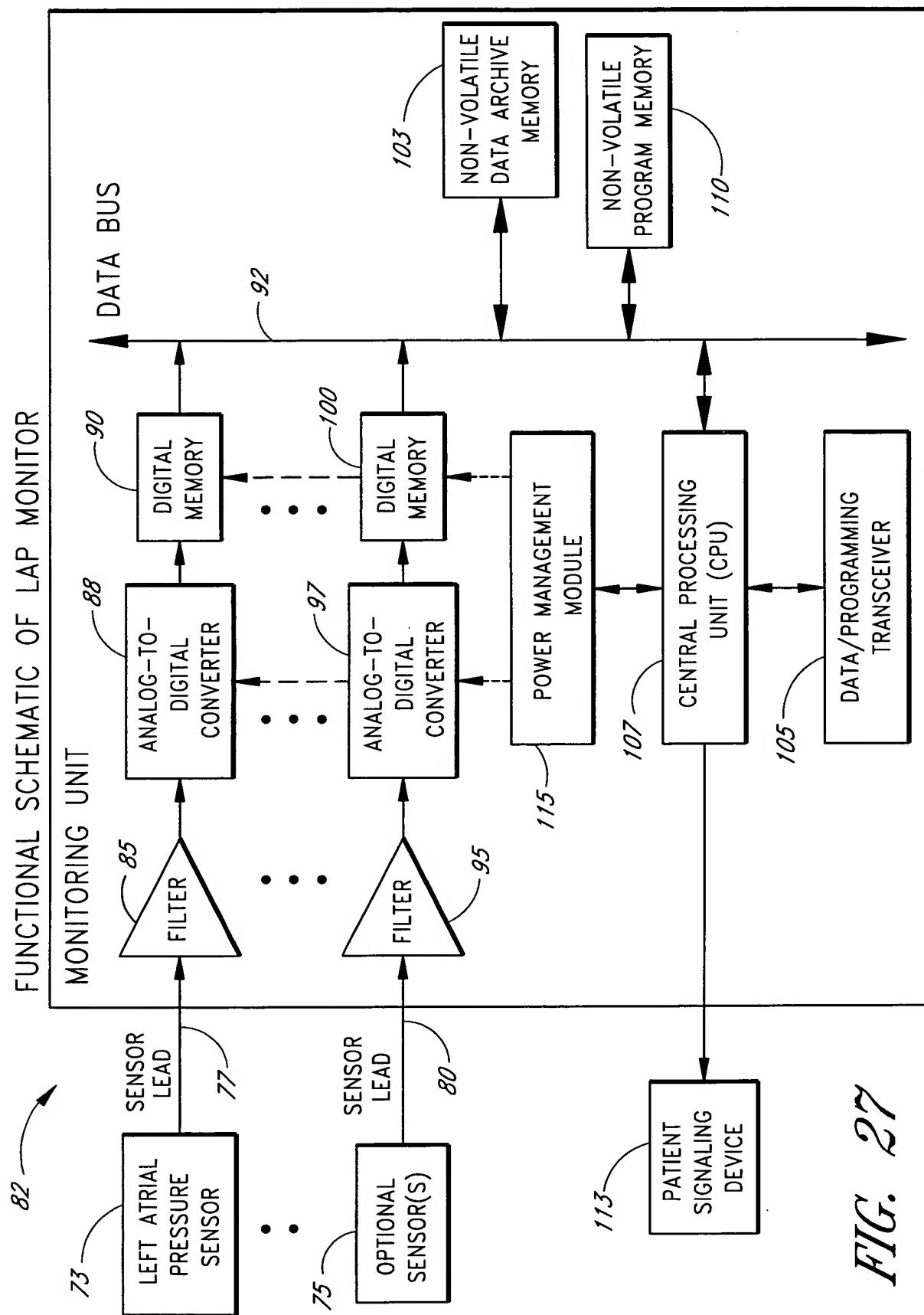


FIG. 27

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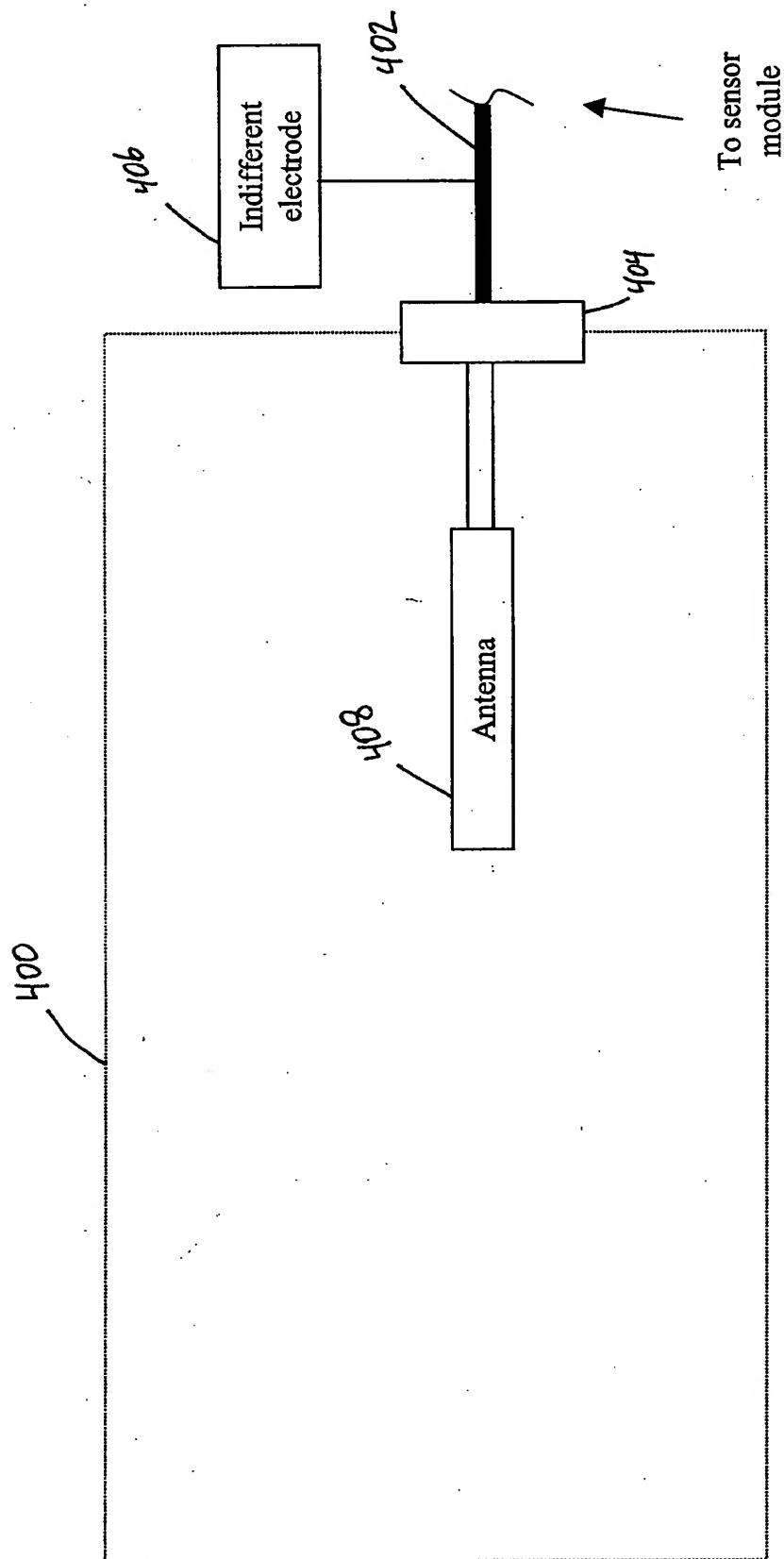


FIG. 28

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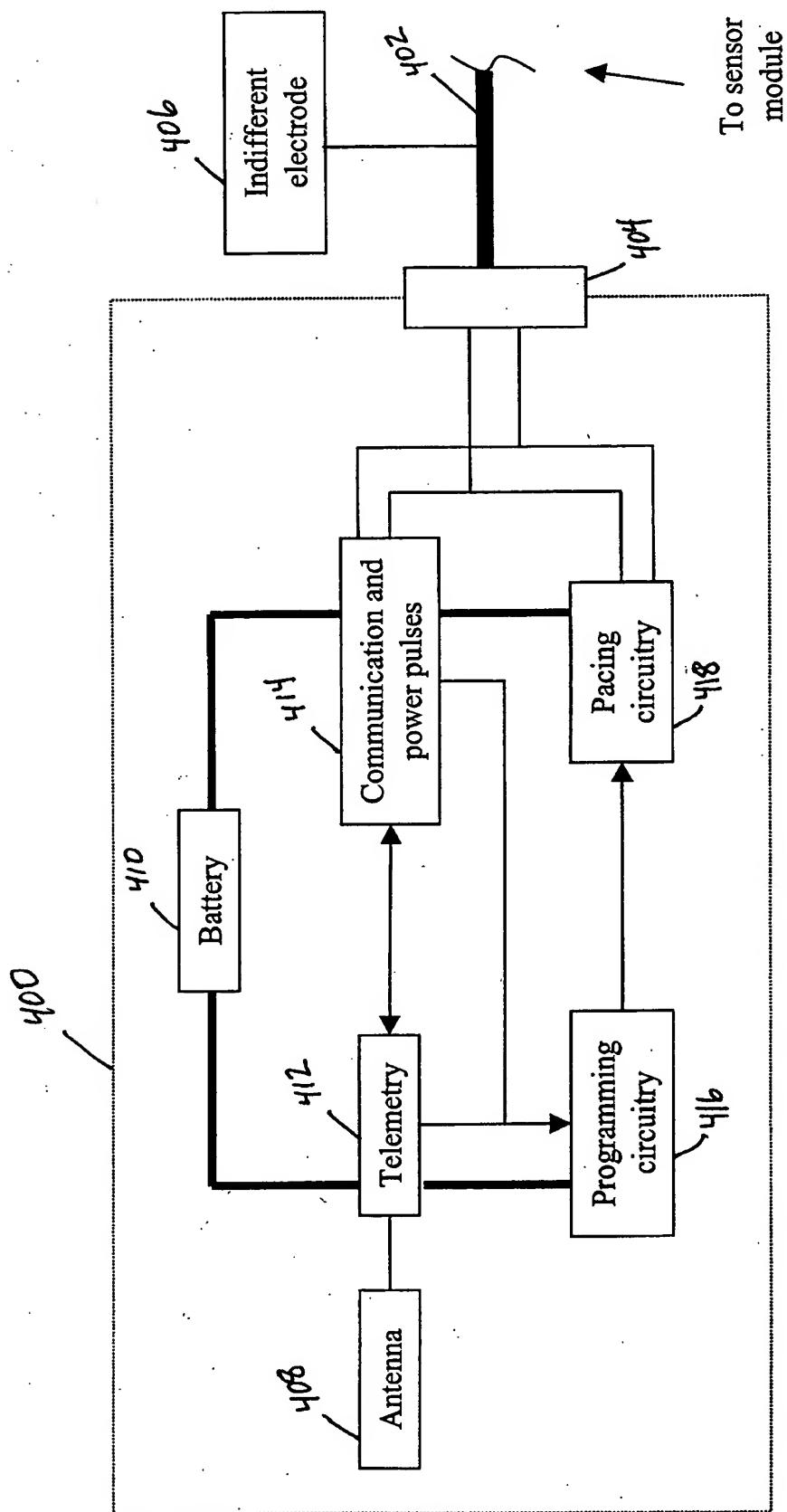


FIG. 29